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Internet Technology for Schools

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With a Foreword by Joel J. Mambretti, Director of the International Center for Advanced Internet Research, Northwestern University

FOREWORD

The Internet has become a crucial resource for educators at all levels, from Ph.D.-granting institutions to K-12 schools to specialized education facilities. In a sense, this outcome was predictable given the origin of the Internet within the research and education community. The topic of Internet-enabled education is particularly important for K-12 institutions because these institutions will increasingly be introducing students to technological resources that have become pervasive in the digital age. Also, some of the most meaningful lessons that are already being taught go far beyond the technology per se. They include instruction about appropriate use of technology, collaborative interactivity, communication, potentials and limitations of technology, dynamic change, complexity, and resource sharing. These lessons will be useful to students for the rest of their lives as they prepare to live in an ever more complex, technology-based society.

However, the challenge of successfully implementing the Internet in schools should not be underestimated. Accomplishing this goal will require undertaking many significant, complex projects. The most significant of these projects cannot be accomplished from outside the educational community. The critical tasks required to successfully implement traditional and emerging Internet technologies can be accomplished only by educators skilled in adapting such technologies to their specific needs.

Unlike the majority of the materials on this topic, this book presents issues from an educational rather than technological perspective. The Internet provides a wide range of powerful enabling technologies to educators. Consequently, discussions of this topic often focus primarily on those technologies to the exclusion of other important, related issues. Yet, those are usually the issues that determine whether or not a project will succeed. The Internet is merely a means to an end, not an end in itself. For educators it is fundamentally a tool, albeit extremely powerful. To successfully implement and utilize this tool within schools, educators must also undertake to address a number of related tasks, including policy development, goal setting, standards selection and implementation, evaluation of new methods of curriculum development and implementation, and new means of forming cooperative processes.

Forming cooperative partnerships is key to developing a productive Internet-enabled educational environment. The successful development of the Internet demonstrates the measure of what can be achieved through such partnerships. The history of the Internet is one of an extensive cooperative undertaking, with membership drawn

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from among many different communities that have decided to work together for mutual benefit. Similarly, it is notable that the most successful Internet implementations in schools are based on such partnerships. I have been fortunate in having had opportunities to be a participant in Internet partnerships for K-12 education. No other technology is so conducive to forming successful partnerships, especially through its powerful new means for communication and information exchange.

It is notable that the most forward-looking leadership in Internet-enabled K-12 education has come from within that educational community. Today, there are many demonstrations of this community's remarkable achievements in utilizing Internet technology. Numerous exciting, innovative projects in Internet-enabled education, far too many to present in this book, have shown enormous potential for enhancing education and learning. Through such leadership, and through the sharing of successful results, educators are providing their students with many new wonderful paths to knowledge and a deeper understanding of their world.

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FROM CHAPTER 2, Connectivity Policies for K-12 Schools, pages 43-47

Note: References and footnotes have been excised from these samples.

SCHOOL ADMINISTRATION

Since administrators are often initiators of their school's technology projects, and since administrative issues tend to arise immediately upon the commencement of an Internetworking project, administrators (in particular, principals and their staff) are usually among the earliest to confront new Internet-related policy issues. Administrators are often the first in a school to use computers and the Internet: according to the President's Committee of Advisors on Science and Technology, in 1995 about fifty percent of all public schools had some kind of Internet connection in their administrative offices, though only a very small percent had classroom access. Furthermore, while the whole school and community need to be involved in the decision-making process, a number of issues ultimately devolve to school-system administrators alone.

The school's administration must set policies for a wide-range of issues, from legalities (such as copyright protection and computer crime) to what role the school's library will play in both the implementation process and instructional use of the Internet. These policy matters can generally be divided into two types: (1) matters of priorities and (2) matters of governance.

One of the first issues to arise in any K-12 networking project is a matter of priorities, that is, financial priorities: resources are usually limited, and the need is often great. Buildings and facilities may be antiquated—school buildings tend to have inadequate air-conditioning for computer use, often are constructed with cinder-block and

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other solid walls without conduits in which wiring and cabling can be installed, and generally make do with inadequate electrical systems (for example, low amperage or insufficient electrical outlets in classrooms). As a result, early in the Internet project, as a matter of policy, administrators must often decide how to allocate funds among competing needs, including facilities infrastructure, network technology, and instruction.

[Table 2.1. State Boards of Education on the World Wide Web (as of November 1, 1998)]

These kinds of priority issues should generally be settled before making fundamental technical-design decisions. For example, administrators should determine early in the process what level of Internet service the school requires, can afford, and is practical. Many options are available, as explained in Part III of this book. The school could either adopt an approach in which technology is introduced all at once or a little at a time. Infrastructure barriers (such as solid walls without conduit) may dictate limited Internet access for a certain period of time, or may dictate introduction of the Internet only into parts of a building or campus. If a phased approach is chosen, then administrators should set the priorities for which elements and services will be established first and who will be allowed to benefit from them. School policy should determine the priorities for which students, which teachers, and which administrators will first be given access to the new resources. In addition, administrators should decide which administrative offices should have computers, how printers and other hardware resources will be accessed from them, and which administrative computers should have Internet access. It must be understood that the number of users and workstations on the system has a significant impact on costs, performance of the system, and has other implications for support and security. Any technology in a school is bound to be a finite resource, and priorities should be established to govern its use.

Technical directions should be set for the system by school administrators, as well. For example, in a school system where desktop administrative computers have been in use for some time prior to the introduction of the Internet, it should be decided whether every workstation on the network should now adopt a common set of desktop applications, such as a standardized word-processor and spreadsheet. People tend to become dependent upon their old favorite, "tried and true" programs, and often resist changing to a centrally chosen, standard program. In other words, as a matter of policy, how much independence should be permitted for individual users and how much control should individuals have over the workstations they use?

Administrators should look at the way in which desktop technical support is currently provided in the school system and anticipate changes that will be brought about by the connection of stand-alone computers to the network. Does the introduction of a network mean that separate support resources are required for both the network and for desktop systems? Who should be responsible for this support? Policies governing access to technical support by teachers and students should be established.

In most cases, a school should designate a network System Administrator, who sometimes is a teacher, but may be an administrator or an assigned specialist. In any case, this person should be someone who is willing to take on the responsibility of Internet technical support. Also, it should be someone who has the expertise to fulfill those responsibilities successfully. Numerous policy issues arise from the assignment of this role. For example, the scheduling and workload of the Internet System Administra-

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tor should be carefully managed. Usually, the person responsible for a school's system should have several tiers of backup support, as well. The individual designated as the first tier of system support may not be proficiently expert in all aspects of the system, if that person can rely on external expertise, for example. (For more information on staffing requirements in a "wired" school, see Chapters 4 and 6.)

During the school's Internet planning project, numerous issues of governance and policy will be addressed. For example, the planning process should establish policies concerning who is entitled to be eligible for system accounts—that is, in addition to teachers and learners in classrooms, which administrators, support staff, and others will be allowed to use the system and to which services should each user be entitled.

Once a determination has been made as to who should have Internet access, then the permissible uses should also be determined—for example, should it be permissible for the school's computers to be used for recreational purposes at any time? Should other personal uses ever be allowed (such as students writing personal e-mail to friends or teachers filing their income taxes online)?

Governance responsibilities by administrators include the enforcement of all these policies. Rules and policies should be disseminated to the Internet-user population at the school so that everyone is adequately informed about what is expected of them. Individuals should be assigned the responsibility of overseeing policy implementation. And policies and procedures must also be established setting out the consequences for abuse or misuse of the system. Even though these processes are related to information technology, they can be placed within the context of existing policy governance mechanisms. For example, the general process for dealing with an abusive e-mail note is the same as the one for dealing with abusive handwritten notes. However, special processes may be involved in gathering the factual evidence related to a particular incident, such as an examination of computer-system records. (Security policies and related issues are discussed in detail in Chapter 10.)

FROM CHAPTER 8, The World Wide Web for Classrooms, pages 159-164

WEB RESOURCES FOR K-12 DISCIPLINES

Surfing the Web for educational resources is a delightful experience, something like being able to transport yourself instantly via some fantasy machine from one library, museum, and school to another, all around the world. If you have not yet had the privilege of accessing the Web because your school has not yet established its network, you may not recognize the power of the Internet for education: if so, you are now in for a real treat. In this section, we will list a few of the more-established and useful educational Web sites in several curriculum areas, to provide you with a general idea of what the Web has to offer educators.

The sheer volume of material, though, can be overwhelming. It can be difficult to narrow your search just to the types of information relevant to your needs. To help you, this section suggests some strategies for finding what you need quickly. Chapter 9 explains some sophisticated Web search engines and techniques for using them.

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Types of Educational Materials on the Web

The Web provides many different types of curriculum materials, some just for teachers, some just for students, and some for both. Online you will find lesson plans, curriculum materials, student practice activities, supplemental class materials, discussion groups, bookstores, and software. There are online laboratories in which students can conduct experiments, online art galleries, online musical concerts, interactive fiction, and more. In addition, there are numerous specialized indexes to resources, both on the Internet and in traditional repositories, such as libraries and government printing offices. Most educational associations have a "presence on the Web," which means they maintain a Web site through which you may contact them and obtain access to many (or all) of their resources.

It is important to understand that the Web is an ever-changing, ever-growing entity—it is never the same from one day to the next. While Web surfing on any given day, you may find materials that interest you, only to discover the next day that the sites have apparently vanished or have changed so that you can no longer find what you wanted. For this reason, it is a good idea to become familiar with the sites that are likely to be maintained and supported permanently. Important sites with which every educator should be familiar include: the U.S. Department of Education's Web site, the National Education Association's Web site, and the ERIC Web sites (see below for more information on ERIC). (Note: the Web addresses cited in this chapter were valid as of November 1, 1998. Refer to Chapter 9 for tips on what to do if a Web site address you wish to access appears to have changed.) While these sites are constantly being enhanced (and may drop some materials from time to time), unlike some sites supported by individuals, you can rely on them not only to be there, but they are also excellent indexes to other good sites on the Web. By accessing one of these Web sites, you will find lists of other recommended educational Web sites, and easy-to-navigate, direct links to those other sites.

As explained in more detail below, educators should also be familiar with "search engine" Web sites, such as Alta Vista, Excite, Lycos, and Yahoo!. It is recommended that you choose one or more of these with which to become very familiar. These Web sites allow you to search for educational Web sites located anywhere on the Web and other Internet resources, such as Gopher indexes and archives of newsgroups (refer to Chapter 7 for more information on Gopher and newsgroups). In addition, you will need to be able to help your students use these search engines to conduct their own research. (The teaching task is rather like showing a student how to use a library card catalog for the first time.) Chapter 9 explains Web search engines and provides some tips on helping your students use them, as well.

Government and Higher-Education Sites and Indexes

In addition to the Department of Education, most other federal government departments and agencies maintain K-12 education Web sites. Also, most institutions of higher education maintain sites for K-12 educators and students, both as a public service and to support their own colleges of education. Several professional associations in a variety of fields maintain K-12 Web sites, and there are also several federally funded K-12 educational initiatives whose missions include supplying educational resources on

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the Web. These are excellent places to begin any Web search for curriculum-specific educational materials.

The Department of Education, for example, supports three large-scale repositories and indexes to K-12 curriculum materials of various types. One is Federal Resources for Educational Excellence ("FREE"), which, among other things, provides an extensive list of links to curriculum-specific Web sites, educational technology Web sites, and funding and grant-making entities. The subject areas covered include arts, educational technology, foreign languages, math, physical sciences, social studies, and vocational education, among others.

The Department of Education also manages the National Library of Education. The National Library of Education has been in existence in one form or another for many decades; however, as recently as 1994 its charter was re-established and expanded to serve as a national repository for information on all aspects of education. It provides information to Congress, federal administrators, and to the governments of other countries with questions about American education; it maintains teacher placement databases; and it is a one-stop publication center for the Department of Education.

The Department of Education's other major initiative in this area is ERIC. ERIC stands for the "Educational Resource and Information Clearinghouses," which is actually a cooperative effort of many organizations and institutions to provide a central source for all kinds of information for educators. Some of these are online resources, while others are repositories of other media, especially print, but also audio tapes, video tapes, and slides. All are housed in several different locations around the country and copies may be obtained either online or through the mail or fax. Each clearinghouse specializes in a different content area or function, such as "Assessment and Evaluation," "Elementary and Childhood Education," "Disabilities and Gifted Children," "Languages and Linguistics," "Science, Mathematics, and Environmental Education," and many, many others. A complete list of clearinghouses is available at the Department of Education's Web site. In addition, the AskERIC clearinghouse Web site includes online digests of publications, collections of lesson plans, and many more indexes and collections of information.

Several government agencies maintain Web sites with general K-12 curriculum materials. The Library of Congress, for example, is an essential Web resource. Not only is the entire Library of Congress card catalog available on the Web, but also digital repositories of reference, research, and curriculum materials, such as digital photographs and many complete texts of classical works. The Library of Congress's copyright services are also accessible on the Web, and some of its trademark and patent information.

Along with the Library of Congress, several other federal agencies support the Digital Libraries Initiative, which is designed to promote a national, and world-wide, digital (that is, online) archive. The Web site for the Digital Libraries Initiative includes links to many other online repositories of educational information.

The National Archives and Records Office is a vast repository of digital materials of interest to educators and students in a range of subject areas. It also maintains a Web site just for K-12 schools.

The Smithsonian Institution maintains a Web site for educators in several subjects, including the arts, language arts, science, and social studies. It includes many materials just for teachers.

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All of these resources include information about the use of technology in K-12 education. In addition, the Software Publisher's Association has been very active in studying the use of computers in education and maintains a useful Web site on the topic.

In higher education, the association for information technology specialists, EDUCAUSE, also has been deeply involved in educational technology issues for many years (under its current name and previously as two organizations, namely, EDUCOM and CAUSE). The EDUCAUSE Web site provides useful links to colleges and universities with resources for K-12 educators. A number of universities have been leaders in use of the Web for educational purposes, and, while their Web sites may tend toward content more appropriate for college students and adult learners, they nonetheless have many valuable resources for K-12 educators. Among these are Cornell University, Carnegie-Mellon University, Dartmouth, Indiana University, University of Michigan, Rice University, and the University of Virginia.

An example of a university that provides a wide range of K-12 educational services is Northwestern University, through its "The Collaboratory Project," which (according to its mission statement) "provides consulting, training, technical support, and information services to education, cultural, and nonprofit organizations that are working to use network technologies to advance education. The Project's goal is to establish an easy-to-use, network-based collaborative environment that enables organizations in the greater Chicago region to work together to share information, resources, and expertise." Collaboratory staff provide workshops for educators, on-site visits, and in-class project support. It also supports student activities online in the language arts, sciences, and musical composition; and it helps teachers and librarians create curriculum-specific, virtual libraries on the Internet.

Some commercial organizations sponsor Web sites of interest to K-12 educators, especially companies who sell products and services to schools. These include most computer hardware manufacturers, software companies, and educational publishers. The Global Schoolhouse is a government and privately sponsored Web site for K-12 education, for example. Pacific Bell has an extensive educational initiative program and many online resources for educators.

Lesson Plans on the Web

For the first time in history, as a result of the World Wide Web, teachers from all over the world are able to share their lesson plans with their colleagues. Thousands of lesson plans in every curriculum area are available on the Web—just a point-and-click away from any teacher's desk (if there is a network computer on the desk). Many of the Web sites mentioned above sponsor indexes to other Web sites where vetted lesson plans are posted, and the search engines all index numerous other lesson plan sites. Each teacher should consider posting his or her lesson plans on the Web, as well (using the tools and techniques explained in Chapter 9.)

The Department of Education's Web site sponsors GEM, "The Gateway to Educational Materials," a project aimed at identifying and posting the best lesson plans and other teacher materials for K-12 education. Some of its participants include the Chinese Historical and Cultural Project, the Drug Enforcement Administration, The

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Lesson Plans Page, Neuroscience for Kids, Tramline Virtual Field-trips, and many others.

The search engines are a particularly fertile source of lesson plans. The authors tested Yahoo!, Alta Vista, Excite, and Lycos all by typing a simple search string on their main pages: "lesson plans." Yahoo! produced four "categories," (that is, its own index lists) for lesson plans, and thousands of Web pages containing the phrase "lesson plans." The first page of references included "English and Library Lesson Plans," the "Lesson Plans Page," and "Lesson Plans Using Internet Web Sites." Alta Vista found 80,311 lesson plans pages, and its first page of references included "Social Studies Lesson Plans and Resources," "Teachers.Net LESSON BANK - Featuring over 400 lesson plans," and "Lessons & Curriculum Ideas." Excite, like Yahoo!, identified four main lesson plan "gateways," and its first page of references included "Lesson Stop," "Accessing Lesson Plans Online," and "Lesson Plan Site." Lycos selected four educational resource sites (such as bookstores), and its first page of references included "MERV K-12 Lesson Plans and Resources," "Lesson Plans," and "Facing the Future: The Faculty Room."

A commercial for-fee service called Educational Structures is also available on the Web. It purports to have over 10,000 hours of online classes and lessons plans. *The New York Times* has a Web site for K-12 education with activities for students and lesson plan archives for teachers.

FROM CHAPTER 11, Your School's Place on the Internet, pages 235-238

DESIGNING SECURE INTERNET SERVICES FOR A SCHOOL

The school's network System Administrator is responsible for establishing a secure network that embodies and facilitates the school's written security policies. The school's network design documents must list the types of information to be protected, who should have access to restricted information and who should not, and should provide an adequate budget for security software and its administration. Among the software applications that are advisable for a K-12 school are secure clients, encryption of passwords and some other types of information, and firewalls.

I-A-A-A

Network software systems must include means of identifying its users, authenticating users' identities and "credentials," setting levels of authority and access, logging the activities of users and any violations or attempted violations of privileges, accounting for the system resources used, and so on. These features are called I-A-A-A, or Identification-Authentication-Authority-Accounting. The school's network System Administrator is responsible for managing this network function.

The most common form of I-A-A-A security is implemented through log-on IDs and passwords. The system verifies that the password entered by a user matches the password associated with an individual's log-on ID (this is "identification"). The school's network System Administrator is responsible for assigning and registering user

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log-on IDs, and for assigning an initial password, which the user can change according to personal preference and for added security. School policies should state that passwords should be changed frequently, to prevent their accidental distribution and to prevent hackers from using well-known passwords. Users should also be instructed on how to avoid passwords that are easy to guess or duplicate, such as pet names, people's names, and birth dates. Software is available to enforce compliance with such policies, for example, not allowing passwords that can easily be compromised. In addition, only the most-trusted individuals should be given root user IDs and passwords.

"Authentication" is the function of attempting to verify that the password belongs to the log-on ID, that it is the current password, and, in some cases, whether the log-on ID has been issued from a network computer that is legitimately able to use that ID and password. For example, users of Telnet may log-on to the Telnet server from almost anywhere: the security system may include a range of computers from which this is not allowed, such as computers in a library open to the public.

"Accounting" is the function of monitoring system resources and allocating resources to individuals. Not only must the security system allow access to some resources, but it may need to keep track of the amount a given individual uses a certain resource for budgetary reasons or other reasons. Some resources may only be made available for a fee, and, if so, the security system must "lock out" users who are remiss in their payments. Some resources may be allocated according to proportional measures, for example, the number of pages printed at one time. Accounting software also helps a network System Administrator optimize system performance.

Encryption programs can be used to protect highly sensitive, confidential files. To greatly oversimplify the process, most encryption software works by scrambling the original information in accordance with a formula. Sometimes a technique is used that involves multiplying a known number by a very large secret number (actually a binary number of a fixed number of bits, such as 32 bits or 128 bits). In order to decode the encrypted key number (that is, reduce it to its original, known number), it is necessary to have possession of the secret number and then divide the code by it. When the encoded number is sufficiently large, the only way to illicitly determine the original number (the password) is by systematically attempting to divide the number by all the possible whole numbers that could have been used as the multiplier: this requires a very powerful computer or a very long, time-consuming process. Using such software, passwords and files can be "scrambled" so that they can only be unscrambled by individuals possessing the encryption key. A popular encryption algorithm (see the Glossary) is called Pretty Good Privacy (PGP). PGP is a "double-key" system in which both the sender and receiver possess halves of the key to the encryption code. This technique makes the process of decoding the password doubly difficult. It works a little like a padlock with a key hole on each side into which different keys fit: to open the lock, a specific key must be inserted into the one side and then a different, specific key must be inserted into the other side in a specific sequence.

FIREWALLS

A school's network may also have a firewall to protect its system from the outside world. A school's written policies should include a statement about the types of information the school wishes to publish or distribute over the Internet (that is, the

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types of information it wishes to allow the outside world to access), as well as the types of information it wishes to protect from outside access. Based upon these policies, the network System Administrator must establish a hardware and software barrier between the school's LAN and the Internet. One type of protective barrier is called a "firewall."

It is the role of the school's network System Administrator to select firewall software, design the implementation of the firewall, set up the firewall's security parameters, monitor activity that passes through the firewall, and investigate security breaches of the firewall.

Technically, a firewall is a two-way security system between any two networks, not only between a LAN and the Internet; a LAN never includes a firewall to protect one of its nodes from the others, but instead has a firewall to protect the whole LAN (called the "inner network" in a firewall environment) from an external network, such as the Internet. Conceivably, two LANs could be shielded from each other by a firewall, but this is unlikely in a school.

The primary purpose of a firewall is to prevent unwanted intrusions into the inner network, but it also prevents unwanted outward-bound communications. A network firewall works just like a building's firewall: while the threat of fire may be greater from one direction than the other, the wall prevents the spread of fire in both directions and consequently impedes traffic in both directions.

A firewall also tracks all transmissions and provides system statistics, logs anomalies, and alerts the network System Administrator when unwarranted transactions have been requested. This information is important, because hackers must usually make repeated attempts to defeat a firewall before they are successful. The records of these attempts are accumulated in the firewall logs, and a watchful network System Administrator can detect and prevent attacks using the logs, in effect, to catch the culprits in the act.

Since client computers outside (as well as inside) the school may request communications from the school's servers, and since the school's servers will respond automatically unless otherwise previously instructed, the security firewall must function in both directions. Even though some of the school's servers may never initiate a transaction, they are designed to respond automatically to authorized client requests, thus exposing the school to the possibility of accidental distribution of confidential information.

For this reason, firewalls are bi-directional, not to thwart clients on an inner network from improperly communicating with the outside world, but because all Internet communications are bi-directional, though almost always initiated from the outside. Data is sent by a client (often outside the school) to a school server in the form of a request; the requested data is then sent from the server to the client. Very few communications are initiated by a server from inside the school: an e-mail server initiates a transaction, when it sends mail and, with mailing-list software, may automatically distribute batches of e-mail without the intervention of an e-mail client, but few other server types initiate any transactions. For example, Web pages are always requested by a client and downloaded; FTP connections are always requested by a client, and files are then transferred by the server; Telnet sessions are always initiated by the client; and so on.

Because a firewall affects communications in both directions between networks, a school's firewall has an impact on what the school's internal clients can accomplish on

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the network and on the ease and speed with which clients can accomplish their objectives. The design of the firewall must take into account these conflicting requirements for data security and ease of use. The approach to this problem is known as the "stance" of the firewall, that is, whether the firewall is designed primarily to protect the school's information from the outside or to allow the school's clients to freely access the Internet. Another way to look at it is that the stance of the firewall is either to screen out unwanted transactions or to permit only desirable transactions.

The choice of stance is a technical, not a policy, matter. The stance may affect the degree of security for any given server inside the school, or the ease with which the network System Administrator can police the servers, but not which servers should be secured (that is a policy matter). Depending upon the stance chosen and the software that implements it, network users will have more or fewer problems accessing servers outside the school, with a concomitant level of complaints and problems to be resolved by the network System Administrator.

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What are reviewers saying about Catherine Mambretti's *Internet Technology for Schools?*

". . . this title will be welcomed . . ." — *Booklist*, July 1999

"*Internet Technology for Schools* is literally a 'soup to nuts' tour through the world of the Internet and how the Internet can apply to education. . . . Numerous references, a glossary, and a comprehensive index complete this unique work that can be of use to educators at all levels, for both planning and expanding the Internet. The concepts presented therein are basic and solid, and should be of value and credible or many years to come."—*Reference and User Services Quarterly*, Fall 1999.

"The author understands the evolving nature of technology and realistically states the personnel implications of having the Internet in a school setting. Any technical information is written for the layperson. . . . A reader will finish this book with a greater knowledge of current and future possibilities. . . ."—*LISCA99*